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Examiner: ~~LD, SIKYIN~~
Art Unit: 1742
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants	:	Yasunari YOSHITOMI et al.
Serial No.	:	09/783,408
Filed	:	February 14, 2001
For	:	THICK GRAIN-ORIENTED ELECTRICAL STEEL SHEET EXHIBITING EXCELLENT MAGNETIC PROPERTIES

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. §1.132

SIR:

I, TOMOJI KUMANO, declare as follows:

1. I graduated from Kyushu National University, Master Course in metallurgy, in March, 1978. I have been employed by Nippon Steel Corporation, Tokyo, Japan, since April 1978. From 1978 to 1985, I was engaged in the manufacture and quality control of electrical steel sheet at the Yawata Works. From 1986 to 1990, I worked at the company's office in Germany. From 1990 to the present, I have been engaged in research and development work at the Yawata Works.

2. I am well versed in the subject application, which is a continuation-in-part application under 35 U.S.A. §120 of prior Application No. 08/116,152 filed September 2, 1993, and with the

contents thereof.

3. I am well versed in the contents of the Office Action Summary of January 15, 2004, issued in respect of the subject application. In the Office Action Summary, the Examiner points out the following.

"Applicants' argument in paragraph bridging pages 6-7 of the remarks filed on July 2003 is noted. But, there is not factual evidence to support applicants' position that 0.36 mm sheet thickness is critical." (Action item 8.)

4. In the case of conventional grain-oriented electrical steel sheet the tendency was to reduce the thickness in order to improve the core loss. Specifically, sheet thickness was reduced within the range of 0.35 mm to 0.23 mm.

In manufacturing transformers, grain-oriented electrical steel sheets are stacked to fabricate cores of prescribed sizes, so using thick steel sheets decreases the amount of work involved. From transformer manufacturers, there was a very strong demand for ways of decreasing the number of stacking steps and improving work productivity. However, the fact was that using thicker grain-oriented electrical steel sheet sharply increased the manufacturing cost, resulting in higher prices. 0.35 mm represented a compromise between manufacturing ease, including in terms of cost, and the demand for thicker sheet by the transformer manufacturers. Conventional commercial products relied on steel sheets up to that thickness.

There is a major difference between how customers use products with sheet thicknesses up to 0.35 mm and thicknesses 0.36 mm and thicker. With respect to transformer manufacturing, compared to sheets 0.35 mm thick, using 0.40 mm sheet decreases the number of core lamination stacking steps by 14% (0.40 mm/0.35 mm - 1),

and 0.50 mm sheet means a decrease of 43% (0.50 mm/0.35 mm - 1). Thus reducing the number of lamination steps by more than 10% has tremendous value.

In manufacturing grain-oriented electrical steel sheet, in order to achieve a good primary recrystallization texture and secondary recrystallization texture, the melt has to have a carbon content in the order of 0.040 to 0.085%. In the final product the carbon content has to be down to 0.0050% or less, so decarburization is carried out in an intermediate step. The ease of this decarburization is inversely proportional to the square of the sheet thickness. Also, since a tight oxidation layer is formed during the decarburization, thicker sheet (over 0.35 mm) has to undergo two decarburization passes, between which the sheets are pickled in an acid solution, to remove an oxidation layer possessing decarburization-difficulty. This made the manufacturing cost very high, to the extent that, in practice, commercial production was not possible. For example, the difference in decarburizationability between 0.35 mm and 0.40 mm is 31% $((0.40 \text{ mm}/0.35 \text{ mm})^2 - 1)$.

In terms of the task of stacking sheets to form transformer cores, a sheet thickness of at least 0.36 mm was sought, while in terms of ease of decarburization, a thickness of not more than 0.35 mm was sought.

So while 0.35 mm and 0.36 mm are close values, mathematically speaking, in terms of the grain-oriented electrical steel sheet manufacturing process, 0.36 mm is the critical point.

5. In the conventional method of manufacturing grain-oriented electrical steel sheet, the slab was heated to a high temperature in the order of 1350°C, necessitating a high carbon content. In the case of thick sheet, this made the following decarburization annealing more burdensome (longer time between decarburization annealing passes), making commercial production difficult. In

practice, the sheet thickness in the case of both industrial standards and commercial products was up to 0.35 mm.

The catalogue shows examples (Orientcore, Orientcore Hi-B, Orientcore Hi-B, LS).

Nippon Steel Corporation published this catalogue in July, 1988.

According to this specification, the Japanese Industrial Standard (JIS, corresponding to the U.S. ASTM) lists only thicknesses of 0.23 mm to 0.35 mm: there are no standards for sheet 0.36 mm thick or thicker.

The nitriding method used by the subject invention enables the slab to be heated at 1300°C or lower, making it possible to decrease the carbon in the slab. Therefore, the problem of decarburizationability can be resolved, making it possible to commercially produce grain-oriented electrical steel sheet with a thickness of 0.36 mm or more.

6. '471 (Datta) describes a sheet thickness of 0.020 inch, but in Example 1 and Example 11, the sheet thickness is not listed. Also, there is no mention of nitriding.

'758 (Kuroki) describes a sheet thickness of ≤ 0.5 mm, but the sheet thickness in the Example is 0.3 mm. Also, there is no mention of nitriding.

It can therefore be assumed that '471 and '758 relate to the manufacture of grain-oriented electrical steel sheet having a thickness of up to 0.35 mm.

7. The conclusion is that in the technical field of grain-oriented electrical steel sheet, a sheet thickness of 0.36 mm is the critical point.

I hereby declare that all statements made herein of my own

knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that willful false statements my jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

T. Kumano

Tomoji KUMANO

Date: May 13, 2004